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COMPLETE SPECIFICATION

OPTICAL THIN FILM FLAKES, REPLICATED OPTICAL COATINGS AND COATINGS AND INKS INCORPORATING THE SAME AND METHOD

I/We, OPTICAL COATING LABORATORY, INC., a corporation of the State of California, 2789 Northpoint Parkway, Santa Rosa, California 95401-7397, USA,

hereby declare the invention for which I / we pray that a patent may be granted to me/us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

(followed by page 1a)

OPTICAL THIN FILM FLAKES, REPLICATED OPTICAL COATINGS AND COATINGS AND INKS INCORPORATING THE SAME AND METHOD

This invention relates to optical thin film flakes and coatings and inks incorporating the same and a method for making the same and more particularly to optically variable thin film flakes and inks incorporating the same used in anti-counterfeiting applications.

In the past attempts have been made to make lamellar pigment materials in the manner disclosed in Patent No. 4,168,986 with the desire to obtain improved specular reflectivity. In U.S. Patent No. 4,434,010 there is disclosed an article and method for forming thin film flakes and coatings. There is, however, no disclosure as to how optically variable thin film flakes for incorporation into paints and inks can be produced which incorporate the use of subtractive colorants to block out or minimize undesired colors. There is therefore a need for new and improved optically variable thin film flakes, paints and inks incorporating the same and methods for producing the same.

Figure 1 is a flow chart showing the optically variable ink process.

Figure 2 is a flow chart showing the optically variable ink manufacturing process.

Figure 3 is a graph showing the reflectance of a magenta-to-green shifter at 10 incidence.

Figure 4 is a graph showing the reflectance for a gold-to-green shifter at 10 incidence.

Figure 5 is a graph showing the reflectance of a gold-to-green shifter with and without a blue-light blocking pigment.

A process for making an optically variable ink (OVI) is shown in Figure 1. As shown therein in a converting step 201, the flexible web is coated with a solvent soluble polymer. The web is formed of a suitable insoluble flexible material using polyethyleneterphthalate (PET), or alternatively, using polymers such as polycarbonates and Kapton. By way of example, a 142 gauge polyester web can be utilized. The web is coated with an acrylic based polymer. One acrylic based polymer found to be satisfactory is one designated as 517-1 and is manufactured and sold by Thermark Division of Avery International located at Schererville, Indiana. The acrylic based polymer is applied to the web in a suitable manner such as by gravure coating and dried in force air dryers. The polymer coat applied to the web is soluble in at least one solvent. Examples of suitable solvents are acetone and methethylketone. It should be appreciated that other than acrylic polymers, other materials can be utilized for a release layer. For example, instead of using a soluble hardcoat as provided by the acrylic polymer, it is possible to evaporate a thin film coating onto the web which would be soluble in certain liquids. Such a thin layer could be sodium fluoride or sodium chloride which could be dissolved with water. Also it

should be appreciated that other release layers which have very low adhesion could be utilized which would permit mechanical removal of the optically variable thin film either by the use of a vacuum or by the use of air jets.

After the converting step 201 has been carried out, the flexible web can be placed in a vacuum coating chamber for performing the vacuum coating step consisting of depositing an optically variable device (OVD) or optical thin film onto the web as shown by step 202. The optical variable device can be an optical multilayer structure of the type hereinbefore described. Alternatively, it can be of the type described in US Patent specifications 4705300 and 4705356. Optical variable devices of this character can be deposited onto the web in a conventional manner in a vacuum chamber such as by the use of electron beam and resistive heating sources as well as by sputtering.

After the multilayer coating has been deposited on the flexible web, in the vacuum coating process, the soluble polymer layer and the adhering thin film which forms the optically variable device is stripped from the carrier web. This can be accomplished batch wise or in a continuous fashion as shown by step 203 by passing the web through a bath of a suitable solvent, such as acetone. As the soluble polymer layer is dissolved by the acetone, the thin film is separated from the web mechanically. As the thin film is being removed, it breaks into optical flakes which are of a size on the order of 50 to 200 microns. If a continuous process is being used, the web as it emerges from the solvent, can be engaged by a metal doctor blade to

mechanically separate any remaining thin film from the web.

The optical flakes, after they have been removed from the carrier web either in a batch process or a continuous process are then reduced in size as hereinafter described and formulated into an ink as shown by step 203. Thereafter, the ink can be utilized in various printing processes as shown by step 204.

A more detailed manufacturing process for making optically variable ink from an optical variable device manufactured in the manner hereinbefore described is shown in Figure 2. As shown therein, the soluble polymer coated web or substrate is prepared in step 206 as hereinafter described. The coated web is then supplied to a vacuum roll coater in roll form as shown in the step 207. In the vacuum roll coater, a thin film multilayer coating can be applied over a given width using a single evaporation source with appropriate masking or can be applied to almost the full width of the vacuum roll coater using multiple evaporative sources and appropriate masking. After coating by vacuum evaporation, the web is removed from the roll coater and is slit to remove any defects or unwanted trim (edge non-uniformities).

During this editing process, the spectral properties of the thin film coating can be ascertained and supplied to a computer to provide a running color average of the coating. This makes it possible to modify the color at a later step as hereinafter described in the event that the color is slightly off the desired color for a particular roll. This makes it possible to custom blend to obtain an exact color

by either adding a lower or a higher color. By having available a color profile extending along the width and length of the web, it is possible to ascertain the average color of each given roll. By way of example, if average dominant wave length of a roll is, for example, 495 microns and the desired wavelength is 490 microns, this desired wavelength can be obtained by adding some lower wavelength material having a wavelength of 485 microns to achieve the desired 490 microns.

In the next step 211, the thin film is stripped from the web. By way of example, this can be accomplished by taking the rolls and placing the rolls on an unwind roller and having the web pass through a solvent bath and then being taken up by a wind-up roller. The web as it passes through the solvent bath can pass through a series of rollers which are positioned below the level of the solvent bath. If any of the thin film coating still remains on the web as it emerges from the rollers in the bath, this remaining thin film can be removed by a metal doctor blade which scrapes the remaining thin film from the web. The doctor blade typically is positioned on the outside of the roll on the wind-up side so that any adhering flake will fall back into the solvent bath. As explained previously, the flakes in this operation have a tendency to drop off in sizes of approximately 50 to 200 microns.

The flakes as they fall from the web will fall to the bottom of the tank containing the solvent because they have a much higher specific gravity as, for example, approximately 3 whereas the solvent has a specific gravity of approximately 1. After the settling has occurred, the clear solvent liquid above the flakes can be drained from the upper part of the tank